

Climate Change Adaptation and Transportation System



Climate Change Adaptation and Transportation System

California Department of Transportation

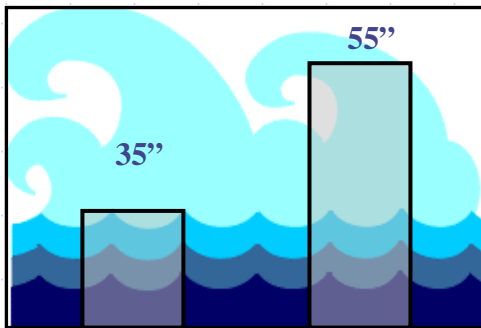
Objective:

- Proactive steps to assess vulnerability of the transportation system to climate variations.
- Mainstream climate change and adaptation into transportation investment decision-making.

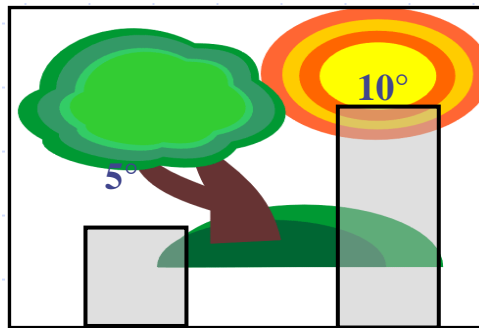
**Climate Strategies + Changing the Way we Plan, Build, and Operate
(Institutionalizing Climate Consideration into the Dept's Business Operations)**

California's Future Climate of Greatest Relevance to Transportation

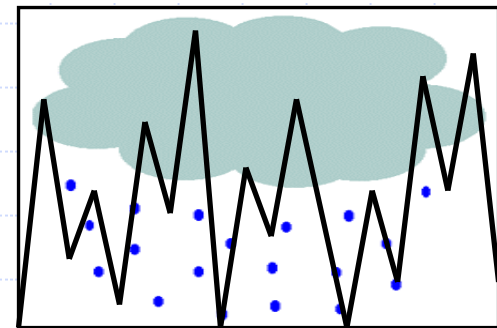
- Sea level rise and storm surge with virtual certainty of 99% probability of occurrence.
- Increased frequency and severity of hot days and heat waves with 90% probability of occurrence.
- Changes in precipitation events with undefined timing, intensity, and variability of precipitation.



Sea level rise scenario 2099



Increased temp. scenario 2099



Precipitation scenario 2099

Moderate, but highly variable

CLIMATE IMPACTS ON TRANSPORTATION

SEA LEVEL RISE SCENARIO



San Francisco Airport



San Francisco Bay Area



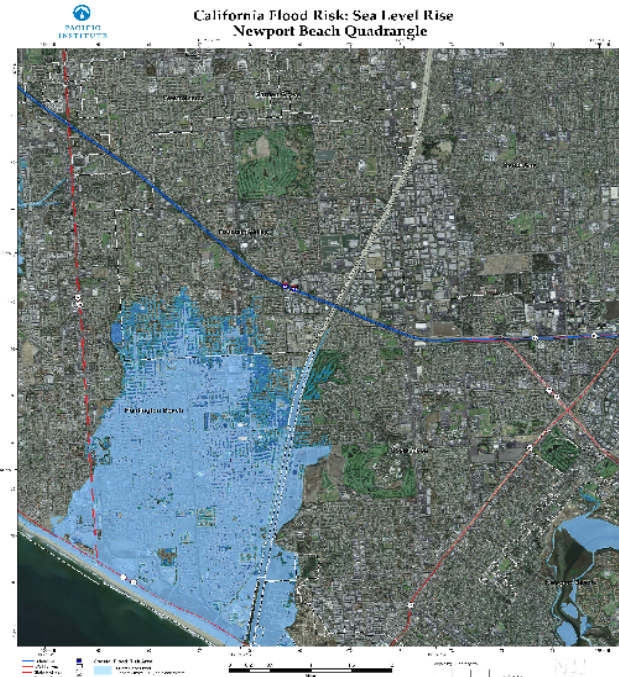
Oakland Airport

CLIMATE IMPACTS ON TRANSPORTATION

SEA LEVEL RISE SCENARIO



**Mendocino, Highway 1 at 55''
by 2099**



**New Port Beach Quadrangle
Inundation Scenario at 55'' by 2099**

CLIMATE IMPACTS ON TRANSPORTATION

SEA LEVEL RISE SCENARIO



Close proximity of coastal development to watershed and flood planes.

CLIMATE IMPACT ON TRANSPORTATION WARMING SCENARIO

Warming Trend – Extreme Heat and Cold



Upward slab movement and shattering at a joint due to extreme heat.



Derailed from warped tracks due to extreme heat.

CLIMATE IMPACT ON TRANSPORTATION

Precipitation, Run off Sensitivities



Massive River at Park entrance - Highway 140, January 2, 1997

JEFF NICHOLAS

Merced River at Park
Entrance, Hwy 140, Jan. 2



Highway 140, washed out in El Portal, January 3, 1997

JEFF NICHOLAS

Hwy 140 washout in El Portal,
Jan. 3 1997

CLIMATE IMPACT ON TRANSPORTATION

Precipitation, Run off Sensitivities

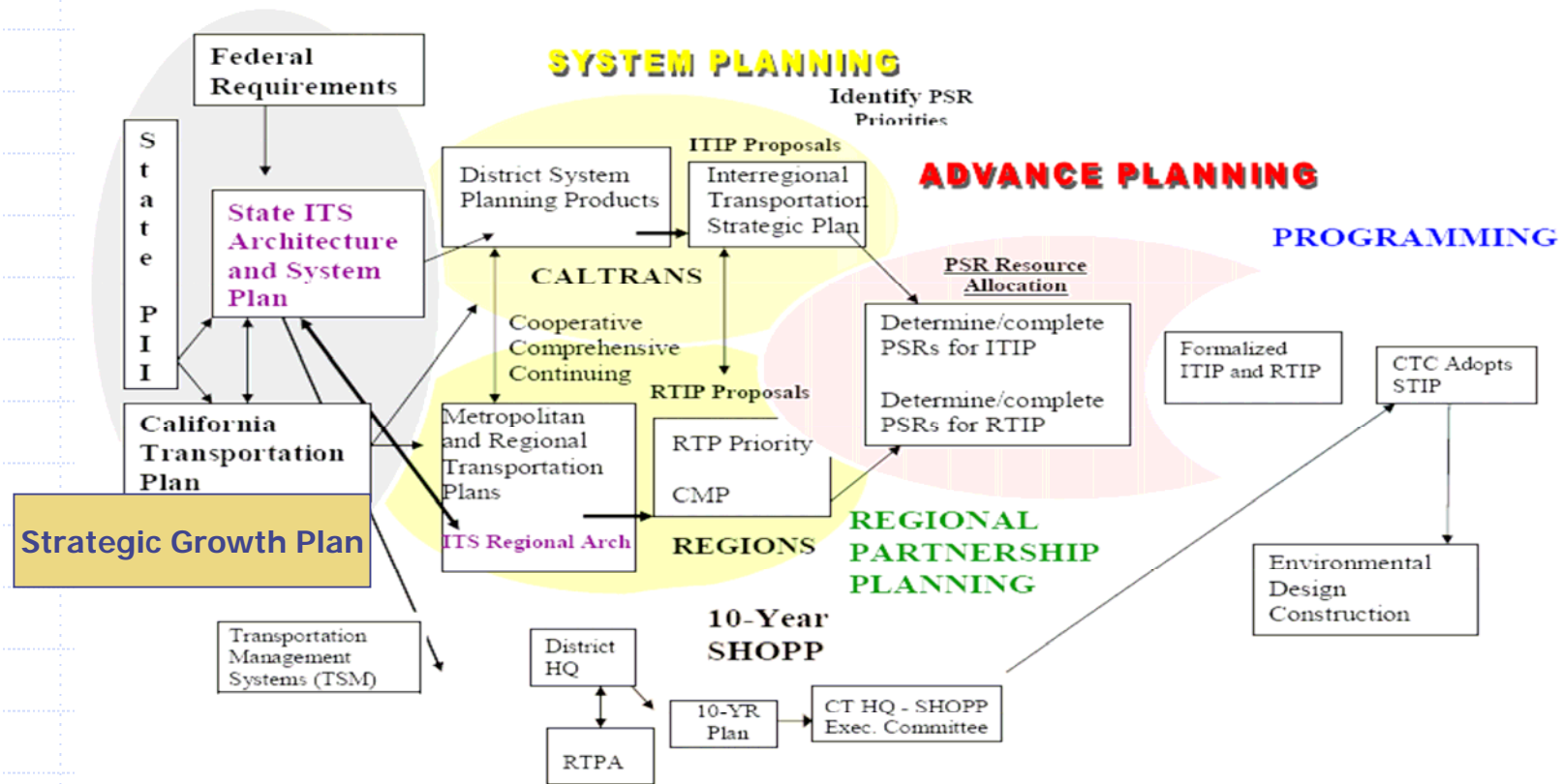


Humboldt County, State Hwy 96 Landslide, February 2007

CLIMATE CHANGE AND TRANSPORTATION DECISION MAKING

- ◆ How to Integrate Adaptation Strategies into complex transportation programming cycles?
- ◆ Not a simple task
- ◆ Require changes in the way we plan and operate: regulations, standards, procedures, Financing and partnership.

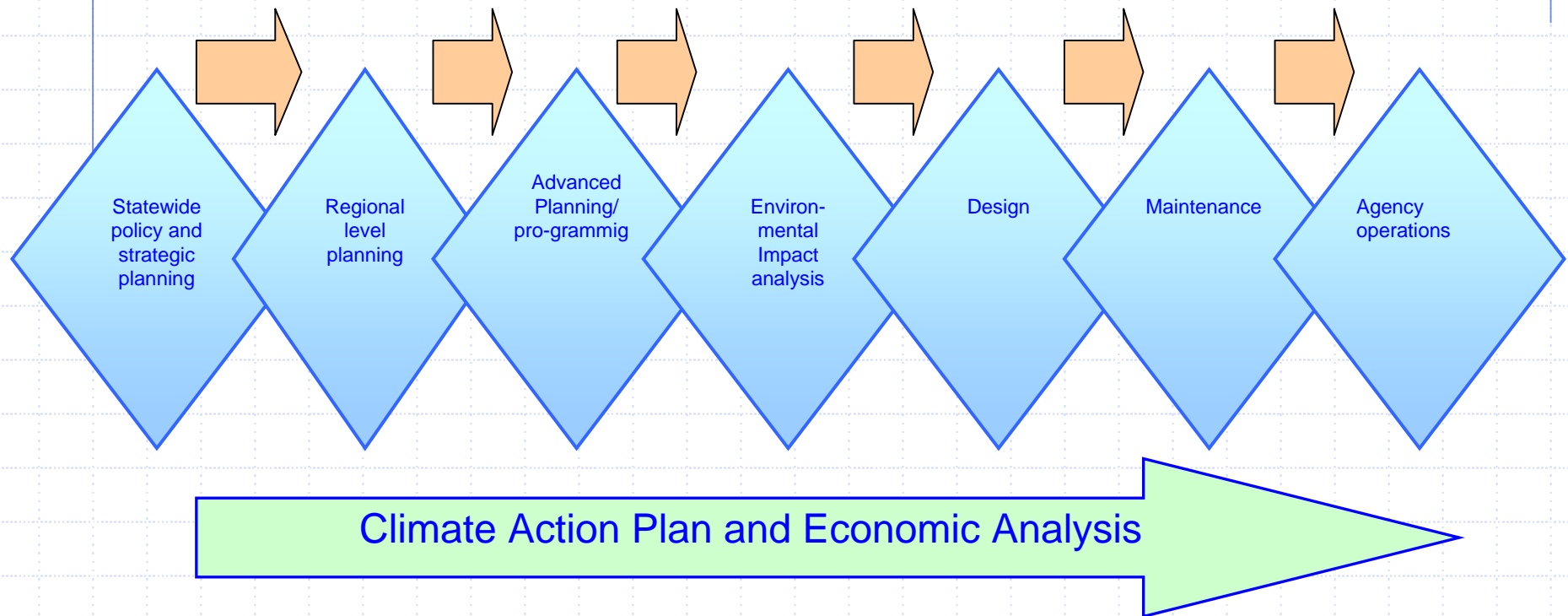
State and Regional Transportation Programming (Simplified Chart)



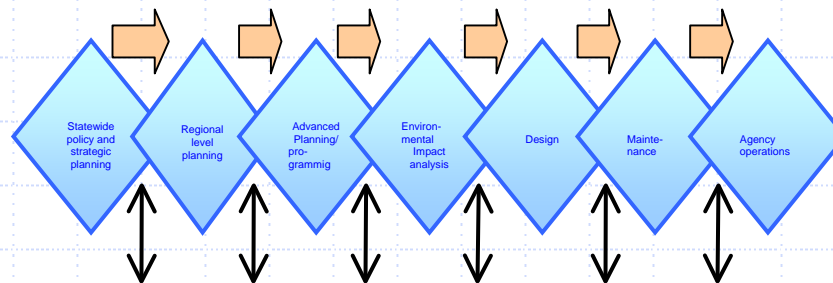
CLIMATE CHANGE AND TRANSPORTATION DECISION MAKING

Integrating Climate Change into Programs and Activities

Department of Transportation



Integrating Climate Change into Transportation Decision Making



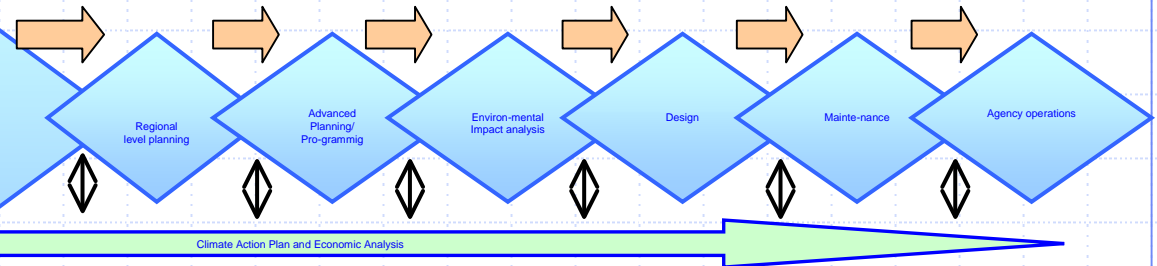
Climate Action Plan and Economic Analysis

Climate Action Program

- Interdisciplinary Program to bridge cross-functional requirements.
- Develop plans, policies, guidelines, technical analysis and reporting protocol
- Mainstream climate consideration into business operations.
- Serve as a resource for technical assistance, research, training, information exchange, and partnership-building opportunities

1.Climate Action Plan 2.Economic and Financial Assessment

Statewide policy and strategic planning

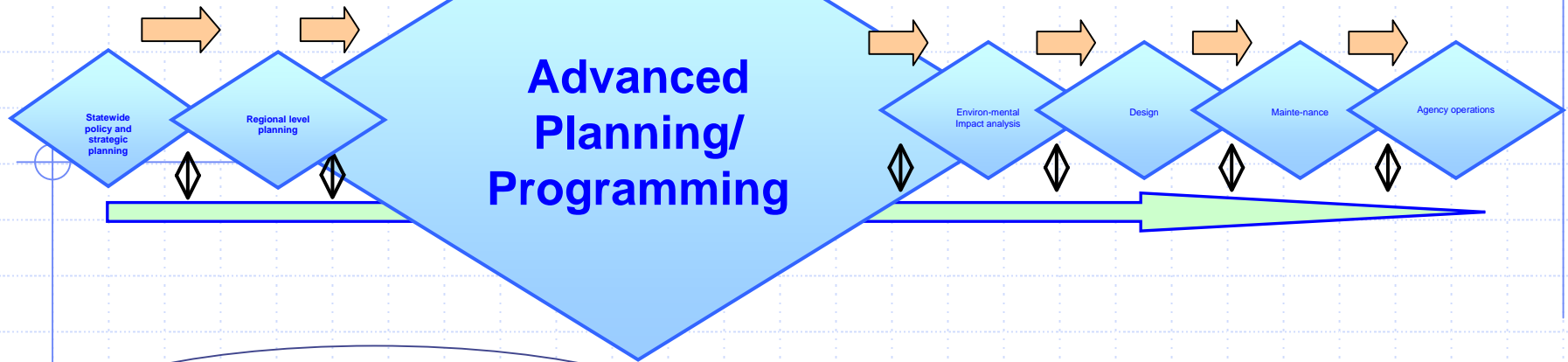


Example Adaptation Strategies

Climate Change Adaptation	
Strategic and System Planning Documents	Adaptive Response
Strategic Plans: Strategic Growth Plan and the California Transportation Plan	<ul style="list-style-type: none"> -Include specific policies that promote adaptation, particularly in the system preservation and environmental sections. Discuss a) the potential impact of climate change on the environment, the economy, and broader quality of life, b) the potential types and levels of threat that climate change poses to the transportation system, c) overall actions to minimize vulnerability, d) education, planning tools, and performance standards on climate change and adaptation, e) institutional support for adaptation, enhance collaboration and research. -Include provisions and exemption for critical investments for short-term safety, operations and maintenance of the system and the economy of the state. -Develop partnership with climate change stakeholders.
Caltrans System Plans:	(Based on information from the Climate Action Plan).
A) District System Management Plan (DSMP)	- DSMP: discuss regionally specific and significant microclimate variations and their regional economic impacts, evaluate impact on the performance and operation of the system in case of disruption. Discuss overall adaptation response or strategies.
B) Interregional Transportation Strategic Plan (ITSP)	- ITSP: provide similar adaptation discussion as DSMP for highway and intercity rail outside of the metropolitan areas, including both strategic planning elements and system planning elements such as corridor- and facility-level needs and strategies related to adaptation.
C) Corridor System Management Plan (CSMP)	- CSMP:
D) Transportation/Corridor Concept Report (TCR)	- TCR: define at risk areas on the particular route or the segments of the road. Evaluate climate impact on travel, modes, and emergency responses. Identify concept adaptation response.
Regional Transportation Plans (TBD)	(Based on information from the Climate Action Plan)

- Adopt policies and strategies that promote adaptation into strategic planning.
- Discuss impacts of climate change on the environment, the economy, and quality of life.
- Adopt actions to minimize vulnerability

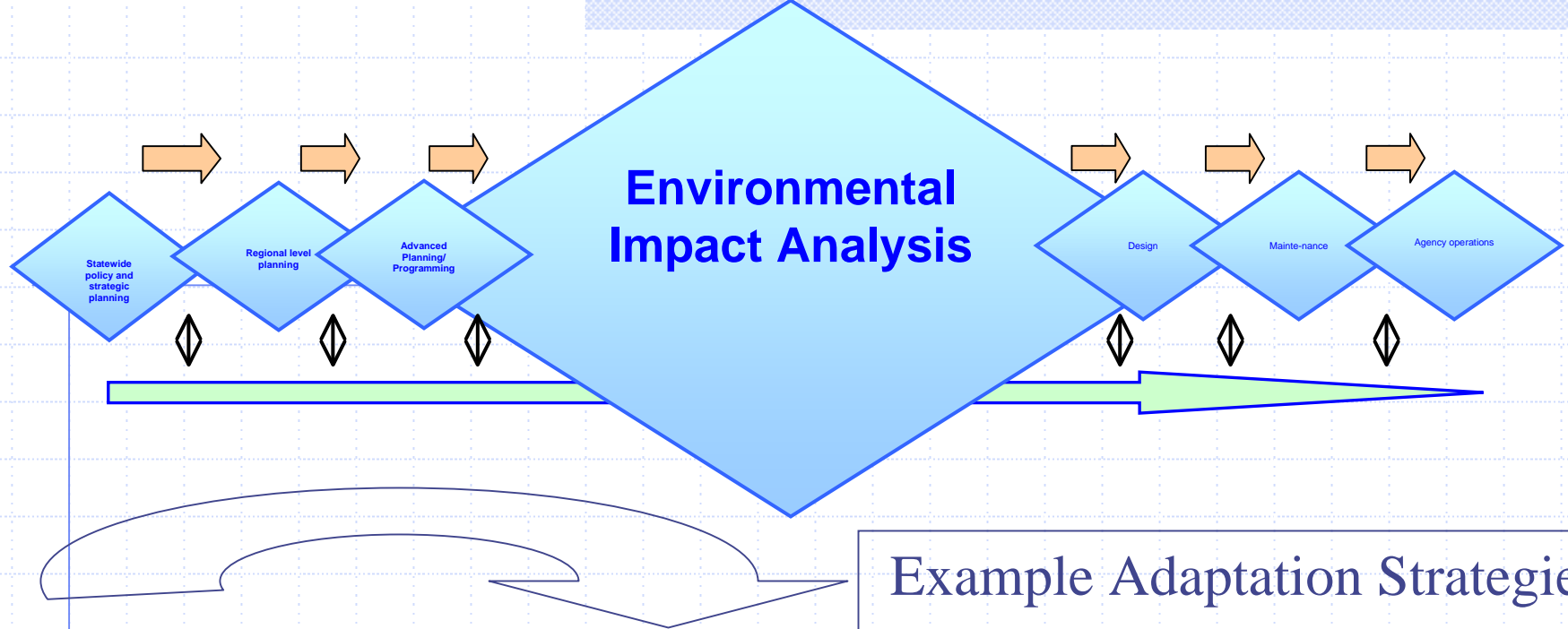
Advanced Planning/ Programming



Example Adaptation Strategies

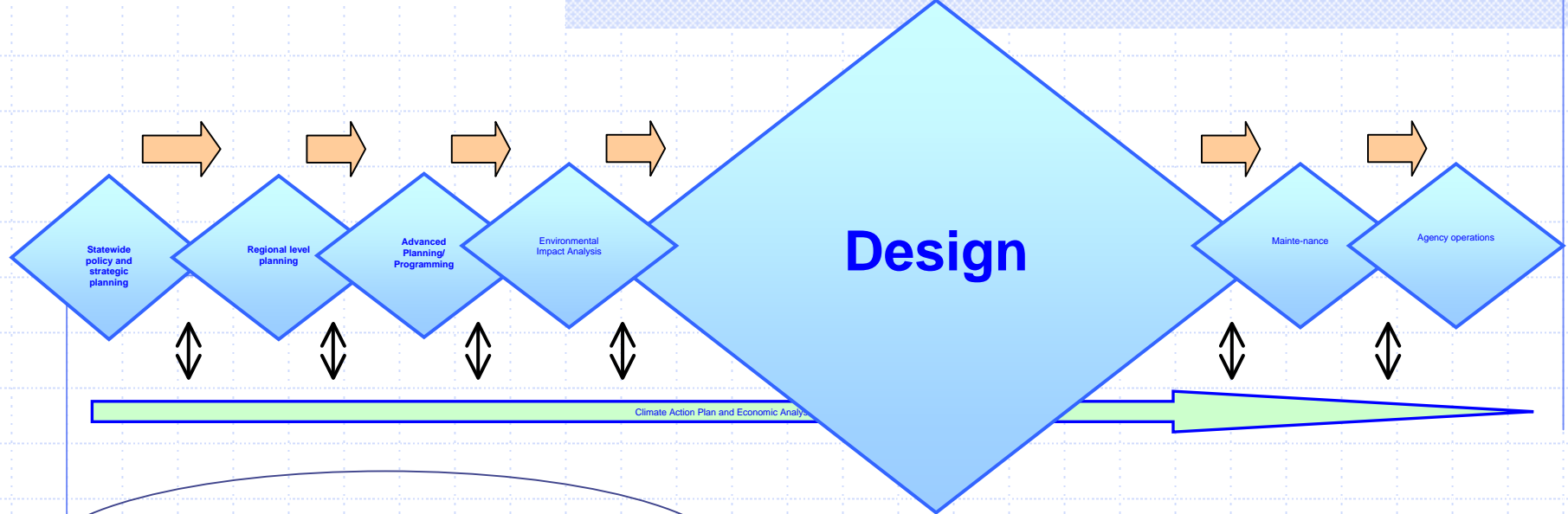
Climate Change Adaptation	
Advance Planning and Programming	Adaptive Response
Advance Planning:	
A) Project Development Procedures Manual (PDPMP)	- Establish adaptation guidance based on strategic value, optimum strategy, and proportionate response to balance risks of doing nothing and protecting the system under scientific uncertainty.
B) Project Initiation Document (PID) i.e., Project Study Report (PSR)	- PDMP: Include guidance for climate change and adaptation strategies.
C) Project Manager and Project Development Team (PDT)	- PIDs/PSR: Include preliminary analysis of the adaptation issues related to the project.
D) PSR Performance Measures (PM)	- PDT: Incorporate climate change and adaptation strategies in the design scope of projects.
E) Exempt Provisions:	- PM: Include criteria for system resiliency and climate protection to reinforce consideration.
	(Based on information in the Climate Action Plan Risk Assessment, or the system plan, or a project level analysis as needed)
Programming:	
F) The State Transportation Improvement Program (STIP)	- Establish provisions for economically significant projects and projected related to safety, operations and maintenance of the system.
G) The State Highway Operation and Protection Program (SHOPP)	- Explore alternative sources of funding and/or develop joint funding arrangement for adaptation projects among stakeholders.
H) CTC Programming Guidelines (CTC PG)	- STIP:
I) Performance Measures	- SHOPP:
J) Exempt Provision:	- CTC PG: support consideration of projects that can improve resiliency or protection of the facility or the system.
	- Include qualitative and/or quantitative matrix related to climate change and adaptation objectives.

- Establish strategic values, optimal strategies, and proportionate responses for climate induced change.
- PDMP: Include guidance for climate change and adaptation strategies.
- PIDs/PSR: Include preliminary analysis of the adaptation.



Climate Change Adaptation: Environmental	
Adaptation Concern	Potential Solution
Increase in number and frequency of emergency projects	-Establish efficient and effective processes for NEPA, CEQA and permit compliance for emergency projects
Need to include adaptation alternatives for transportation projects and/or elements	-Develop better scoping process to integrate adaptation alternatives early in the environmental process -Develop approach for incorporating adaptation alternatives in environmental documents -Develop means to re-validate and update environmental document and permits to include adaptation alternatives -Develop standardize approach to when and where to address climate change adaptation in environmental documents
Need to develop consistent planning scenarios and science for climate change adaptation	-Participate in statewide climate teams and stay current on the science and scenarios -Develop a consistent approach to what is "speculative" versus "reasonably foreseeable" for purposes of environmental compliance
Changes in climate will lead to changes in environmental resources and sensitivity	-Anticipate an increase in the number of endangered species consultation needed -Consider and implement programmatic approaches to resource and regulatory compliance -Work with resource and regulatory agencies on viability of existing mitigation sites
Changes in storm/fire intensity and frequency	-Develop methods to assess and adjust to changes in erosion and storm flows, particularly with respect to stormwater devices and controls

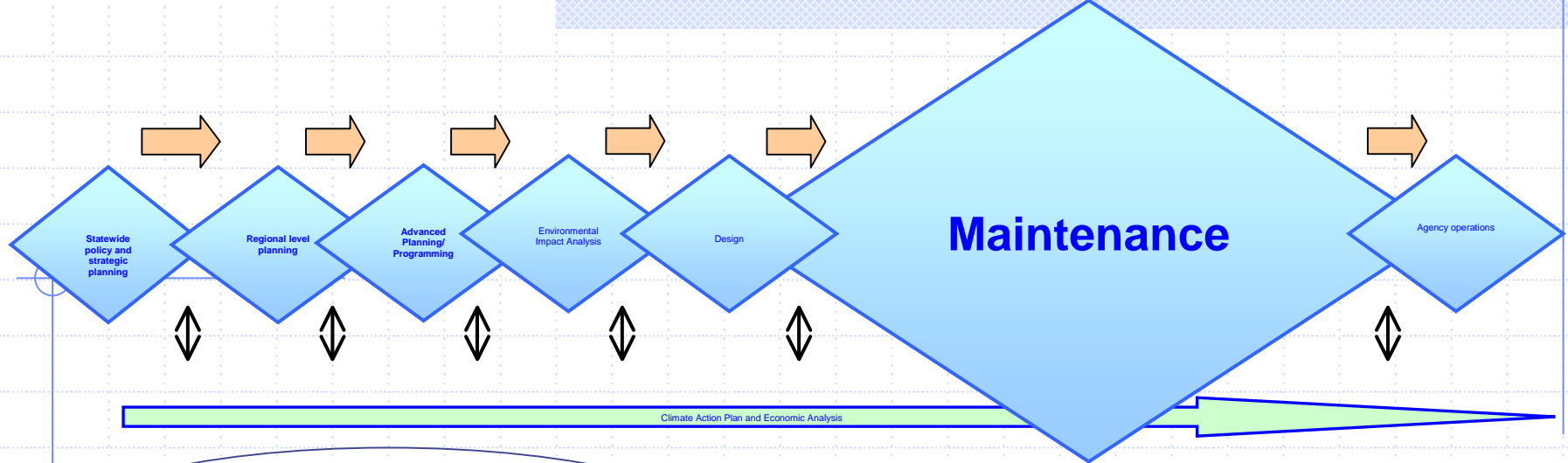
- Establish processes for NEPA, CEQA and permit compliance for emergency projects.
- Develop approach for incorporating adaptation alternatives in environmental documents.
- Develop methods to assess changes in erosion and storm flows.



Example Adaptation Strategies

Impacts on Transportation Infrastructure	Adaptation Options
Inundation of roads and rail lines in coastal areas	Changes in elevation of streets, bridges, and rail lines**
More frequent interruptions in travel on coastal and low-lying roadways and rail service due to storm surges	Relocation of sections of roads and rail lines inland**
Increased potential for flooding and road closures near the mouths of rivers due to backwater effects	Re-mapping of flood zones for different sea level rise projections**
Table 1A Continue.	
Reduced clearances under bridges due to backwater effects	Return of some coastal areas to nature
More frequent or severe flooding of underground tunnels and low-lying coastal infrastructure	Changes in elevation and future protection of bridges, tunnels, transit entrances, and critical evacuation routes: additional pumping capacity for tunnels, strengthening and raising existing and/or constructing new levees, seawalls, dikes or flood barriers. **
Erosion of road base & bridge scour	Increased use of bridge scour monitoring devices
Loss of coastal wetlands and barrier shoreline	Construction of artificial reefs, modifications to wetlands
Land subsidence	Levee improvements and strengthening
Increased corrosion attack to structures from saltwater intrusion into delta areas (e.g. Sacramento-San Joaquin River)	Increased use of corrosion resistant materials for structure design or repair

- Change in elevation of bridges, streets, and rail lines.
- Construct artificial reefs, modifications to wetlands.
- Development of new, heat resistant paving materials with regional changes in pavement design.
- Increased use of open-graded surface textures and/or drainage system re-design

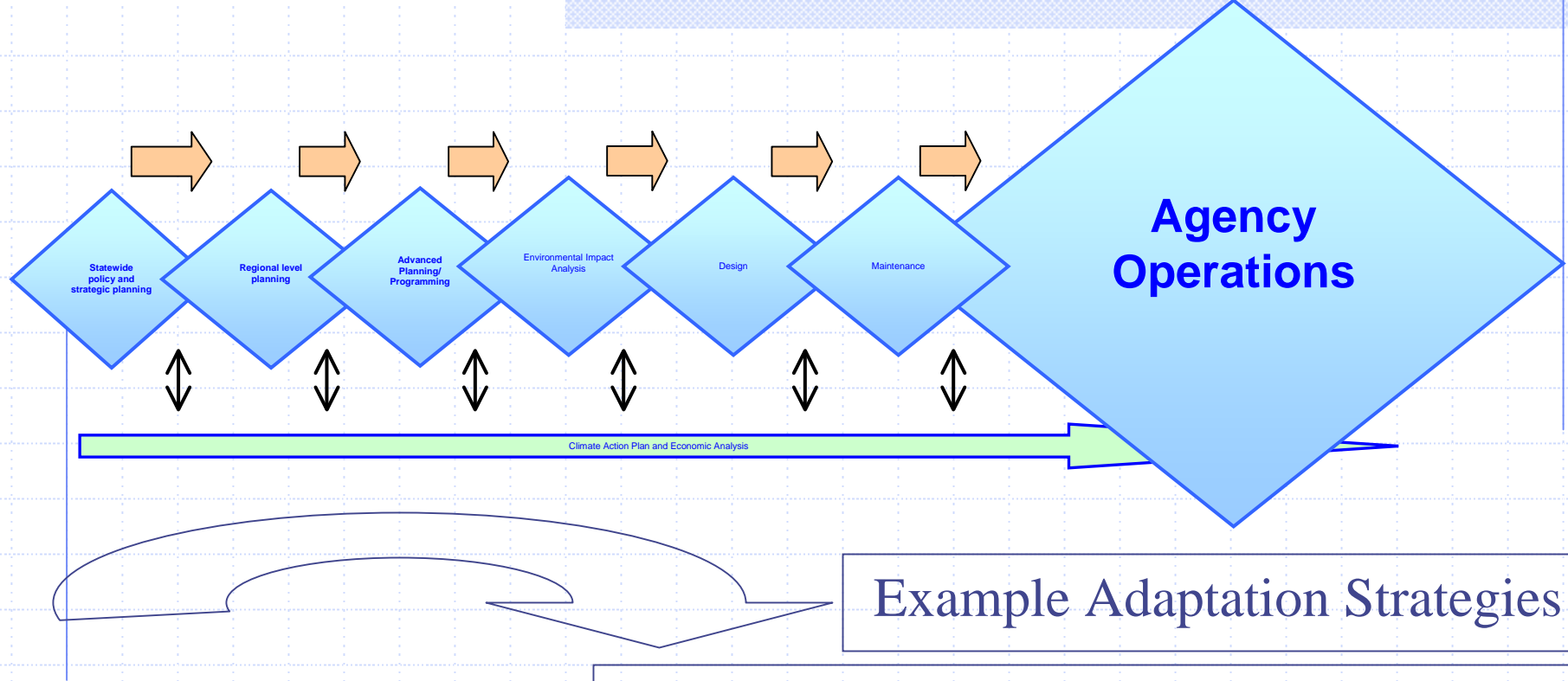


Example Adaptation Strategies

- Grade raises, realignments away from sea, viaducts
- New sea walls or modify existing sea walls
- Increase in major damage projects for debris flows and washouts
- Adopt Florida-style hurricane preparation and response

Climate Change	Physical Impact	Damage Description	Adaptation(s)
Sea Level Rise	Higher sea level raises the daily average surf line	Increased erosion of bluffs Undermining risk to coastal highways Decreased lifespan of existing coastal rip-rap systems Tide gates on culverts submerged	Increase in damage repair projects Repair undermined sections Modify existing rip-rap systems Use of concrete armor units Grade raises, realignments away from sea, viaducts Raise bridges to maintain minimum clearance in shipping lanes
Sea Level Rise	Higher storm surges when storms occur	Higher pounding surf causes short-term flooding of roadways Washout and undermining of coastal highways Levee breaks and extensive flooding of Sacramento Delta highways Damage to existing rip-rap systems	New sea walls or modify existing sea walls Increased damage repair projects Repair undermined sections Modify existing rip-rap systems Use of concrete armor units Grade raises, realignments away from sea, viaducts
Warmer Winter Storms	Change in winter climate patterns. Less total precipitation but higher storm volatility (wilder extremes in precipitation intensity). Less total precipitation Higher precip volatility, intensity	Increase in "rockfall" landslides Increase in mudflows, debris flows Decrease in typical "wet winter" landslides and slumps if total seasonal rainfall declines. Increase in debris flow landslides from higher intensity localized storm cells.	Increase in major damage projects for debris flows and washouts may be offset by decrease in major damage projects for rotational landslides.
Warmer Temperatures	Hotter pavement temperatures Increase in wildfires	Increase in "blowups" -- sudden cracking and tilting up of pavement slabs Increase in wildfires -- increase in damage to wood-based highway infrastructure (guardrail, timber walls, sign posts).	More traffic disruptions and emergency repairs of pavement.
Warmer Pacific Ocean Temperatures	Increased risk of Eastern Pacific making landfall on California.	In a worse case scenario, Los Angeles or San Diego could be hit by a Cat V hurricane. Estimated \$25 billion damage.	Adopt Florida-style hurricane preparation and response Contraflow evacuation routes.





Example Adaptation Strategies

- Integrate Climate information into ITS.
- Alternate day access to highways during heightened exposure, or consider green surcharges for vehicles operated during these periods.
- Address climate exposure and anticipated problems into corridor management plans.

Climate Change Adaptation: Operations (incomplete)	
Adaptation Concern	Potential Solution
<ul style="list-style-type: none"> - Reduced capacity and through put - Impact on safety and maintenance operations - Impact on emergency and evacuation routes. 	<ul style="list-style-type: none"> - Integrate climate information into ITS. - Include climatic scenarios into ITS Architecture. - Address climate exposure and anticipated problems into corridor management plans. - increase staffing TMCs during heightened exposure. - Alternate day access to highways during heightened exposure, or consider green surcharges for vehicles operated during these periods.

CLIMATE CHANGE AND TRANSPORTATION DECISION MAKING

Other Important Supporting Activities

Research

- Improving our understanding of the scale of climate change effects, rate of change, anticipated impacts, and identifying potential responses needs to be the subject of an ongoing, coordinated research program in California.

Regional Equity and Environmental Justice

- Need to assess how equitably climate impacts can be addressed without unnecessarily undermining investment or resource distribution for other regions.
- Need to assess climate implications and responses for low income and minority communities in at risk areas.

CLIMATE CHANGE AND TRANSPORTATION DECISION MAKING

Other Important Supporting Activities

A Collaborative Approach to Climate Change and Adaptation

- Need a coordinated, integrated and multi-agency approach to the climate agenda, including participation by the private sector, non-profit organizations and the public.